CLAIMS

What is claimed is:

1. A method for computing a distance of a received word from a codeword, the codeword being a concatenation of L symbols selected from two disjoint symbol subsets X and Y, the codeword being included in one of a plurality of code-subsets, the received word being represented by L inputs, each of the L inputs uniquely corresponding to one of L dimensions, the method comprising the operations of:

(a) producing a set of one-dimensional errors from the L inputs, each of the one-dimensional errors representing a distance metric between one of the L inputs and a symbol in one of the two disjoint symbol-subsets; and

(b) combining the one-dimensional errors to produce a set of L-dimensional errors such that each of the L-dimensional errors is a distance of the received word from a nearest codeword in one of the code-subsets.

2. The method of claim 1 wherein each of the one-dimensional errors is represented by substantially fewer bits than each of the L inputs.

3. The method of claim 1 wherein operation (a) comprises the operation of slicing each of the L inputs with respect to each of the two disjoint symbol-subsets X and Y to produce a set of X-based errors, a set of Y-based errors and corresponding sets of X-based and Y-based decisions, the sets of X-based and Y-based errors forming the set of one-dimensional errors, the sets of X-based and Y-based decisions forming the set of one-dimensional decisions, each of the X-based and Y-based decisions being a symbol in a corresponding symbol-subset closest in distance to one of the L inputs, each of the one-dimensional errors representing a distance metric between a corresponding one-dimensional decision and one of the L inputs.

4. The method of claim 3 wherein each of the one-dimensional errors is represented by 3 bits.

5. The method of claim 3 wherein the operation of slicing is performed via a look-up table.

6. The method of claim 5 wherein the look-up table is implemented using a read-only-memory storage device.

7. The method of claim 5 wherein the look-up table is implemented using a random-logic device.

8. The method of claim 1 wherein operation (a) comprises the operation of:

(1) slicing each of the L inputs with respect to each of the two disjoint symbol-subsets X and Y to produce a set of X-based decisions and a set of Y-based decisions, the sets of X-based and Y-based decisions forming the set of one-dimensional decisions, each of the X-based and Y-based decisions being a symbol in a corresponding symbol-subset closest in distance to one of the L inputs;

(2) slicing each of the L inputs with respect to a symbol-set comprising all symbols of the two disjoint symbol-subsets to produce a set of hard decisions; and

(3) combining each of the sets of X-based and Y-based decisions with the set of hard decisions to produce the set of one-dimensional errors, each of the one-dimensional errors representing a distance metric between the corresponding one-dimensional decision and one of the L inputs.

9. The method of claim 8 wherein operations (1), (2) and (3) are performed via a look-up table.

10. The method of claim 9 wherein the look-up table is implemented using a read-only-memory storage device.

11. The method of claim 9 wherein the look-up table is implemented using a random-logic device.

12. The method of claim 8 wherein each of the one-dimensional errors is represented by one bit.

13. The method of claim 1 wherein operation (b) comprises the operations of:

combining the one-dimensional errors to produce two-dimensional errors;

combining the two-dimensional errors to produce intermediate L-dimensional errors;

arranging the intermediate L-dimensional errors into pairs of errors such that the pairs of errors correspond one-to-one to the code-subsets; and

determining a minimum for each of the pairs of errors, the minima being the L-dimensional errors.

14. The method of claim 1 wherein L is equal to 4.

15. The method of claim 1 wherein the plurality of code-subsets comprises 2^{L-1} code-subsets.

16. The method of claim 15 wherein the set of one-dimensional errors comprises 2L one-dimensional errors.

17. The method of claim 16 wherein the set of L-dimensional errors comprises 2^{L-1} L-dimensional errors.

18. The method of claim 17 wherein operation (b) comprises the operations of:

combining the 2L one-dimensional errors to produce 2L two-dimensional errors;

combining the 2L two-dimensional errors to produce the 2^L intermediate L-dimensional errors;

arranging the 2^L intermediate L-dimensional errors into 2^{L-1} pairs of errors such that the 2^{L-1} pairs of errors correspond one-to-one to the 2^{L-1} code-subsets; and

determining a minimum for each of the 2^{L-1} pairs of errors, the minima being the 2^{L-1} L-dimensional errors.

19. A system for computing a distance of a received word from a codeword, the codeword being a concatenation of L symbols selected from two disjoint symbol-subsets X and Y, the codeword being included in one of a plurality of code-subsets, the received word being represented by L inputs, each of the L inputs uniquely corresponding to one of L dimensions, the system comprising:

(a) a set of slicers for producing a set of one-dimensional errors from the L inputs, each of the one-dimensional errors representing a distance metric between one of the L-inputs and a symbol in one of the two disjoint symbol-subsets; and

(b) a combining module for combining the one-dimensional errors to produce a set of L-dimensional errors such that each of the L-dimensional errors is a distance of the received word from a nearest codeword in one of the code-subsets.

20. The system of claim 19 wherein each of the one-dimensional errors is represented by substantially fewer bits than each of the L inputs.

21. The system of claim 19 wherein the slicers slice the L inputs with respect to each of the two disjoint symbol-subsets X and Y to produce a set of X-based errors, a set of Y-based errors and corresponding sets of X-based and Y-based decisions, the sets of X-based and Y-based errors forming the set of one-dimensional errors, the sets of X-based and Y-based decisions ~~forming the set of one-dimensional decisions, each of the X-based~~ and Y-based decisions being a symbol in a corresponding symbol-subset closest in distance to one of the L inputs, each of the

one-dimensional errors representing a distance metric between a corresponding one-dimensional decision and one of the L inputs.

22. The system of claim 21 wherein each of the one-dimensional errors is represented by 3 bits.

23. The system of claim 21 wherein the slicers are implemented using a look-up table.

24. The system of claim 23 wherein the look-up table is implemented using a read-only-memory storage device.

25. The system of claim 23 wherein the look-up table is implemented using a random-logic device.

26. The system of claim 19 wherein the set of slicers comprises:

(1) first slicers for slicing each of the L inputs with respect to each of the two disjoint symbol-subsets X and Y to produce a set of X-based decisions and a set of Y-based decisions, the sets of X-based and Y-based decisions forming the set of one-dimensional decisions, each of the X-based and Y-based decisions being a symbol in a corresponding symbol-subset closest in distance to one of the L inputs;

(2) second slicers for slicing each of the L inputs with respect to a symbol-set comprising all symbols of the two disjoint symbol-subsets to produce a set of hard decisions; and

(3) error-computing modules for combining each of the sets of X-based and Y-based decisions with the set of hard decisions to produce the set of one-dimensional errors, each of the one-dimensional errors representing a distance metric between the corresponding one-dimensional decision and one of the L inputs.

27. The system of claim 26 wherein the first and second slicers and the error computing modules are implemented using a look-up table.

28. The system of claim 27 wherein the look-up table is implemented using a read-only-memory storage device.

29. The system of claim 27 wherein the look-up table is implemented using a random-logic device.

30. The system of claim 26 wherein each of the one-dimensional errors is represented by one bit.

31. The system of claim 19 wherein the combining module comprises:

a first set of adders for combining the one-dimensional errors to produce two-dimensional errors;

a second set of adders for combining the two-dimensional errors to produce intermediate L-dimensional errors, the intermediate L-dimensional errors being arranged into pairs of errors such that the pairs of errors correspond one-to-one to the code-subsets; and

a minimum-select module for determining a minimum for each of the pairs of errors, the minima being the L-dimensional errors.

32. The system of claim 19 wherein L is equal to 4.

33. The system of claim 19 wherein the plurality of code-subsets comprises 2^{L-1} code-subsets.

34. The system of claim 33 wherein the set of one-dimensional errors comprises 2L one-dimensional errors.

35. The system of claim 34 wherein the set of L-dimensional errors comprises 2^{L-1} L-dimensional errors.

36. The system of claim 35 wherein the combining module comprises:

a first set of adders for combining the 2L one-dimensional errors to produce 2L two-dimensional errors;

a second set of adders for combining the 2L two-dimensional errors to produce the 2^L intermediate L-dimensional errors, the 2^L intermediate L-dimensional errors being arranged into 2^{L-1} pairs of errors such that the 2^{L-1} pairs of errors correspond one-to-one to the 2^{L-1} code-subsets; and

a minimum-select module for determining a minimum for each of the 2^{L-1} pairs of errors, the minima being the 2^{L-1} L-dimensional errors.

37. The system of claim 19 wherein the system is included in a communication transceiver configured to transmit and receive information signals encoded in accordance with a multi-level symbolic scheme.

38. A method for computing a distance of a received word from a codeword, the codeword being a concatenation of L symbols selected from two disjoint symbol-subsets, the codeword being included in one of 2^{L-1} code-subsets, the received word being represented by 2^{L-1} input sets, each of the 2^{L-1} input sets having L inputs, each of the L inputs uniquely corresponding to one of L dimensions, each of the 2^{L-1} input sets corresponding to one of the 2^{L-1} code-subsets, the method comprising the operations of:

(a) slicing each of the L inputs of each of the 2^{L-1} input sets with respect to each of the two disjoint symbol-subsets to produce an error set of 2L one-dimensional errors for each of the 2^{L-1} code-subsets; and

(b) combining one-dimensional errors within each of the error sets to produce 2^{L-2} L-dimensional errors for the

corresponding code-subset such that each of the 2^{L-2} L-dimensional errors is a distance of the received word from one of codewords.

39. The method of claim 38 wherein L is equal to 4.

40. The method of claim 38 wherein operation (b) comprises the operations of:

combining the 2L one-dimensional errors to produce 2L two-dimensional errors;

combining the 2L two-dimensional errors to produce a set of 2^L intermediate L-dimensional errors;

arranging the 2^L intermediate L-dimensional errors into 2^{L-1} pairs of errors such that the 2^{L-1} pairs of errors correspond one-to-one to the 2^{L-1} code-subsets; and

determining a minimum for each of the 2^{L-1} pairs, the minima being the 2^{L-1} L-dimensional errors.

41. The method of claim 40 wherein operation (a) comprises the operation of producing a decision set of 2L one-dimensional decisions for each of the 2^{L-1} code-subsets.

42. The method of claim 40 wherein operation (b) comprises the operation of combining one-dimensional decisions within each of the decision sets to produce 2^{L-2} L-dimensional decisions for the corresponding code-subset such that each of the 2^{L-2} L-dimensional decisions is a codeword closest in distance to the received word, the codeword being in one of 2^{L-2} code-subsets included in the 2^{L-1} code-subsets.

43. The method of claim 38 wherein the method is performed in a communication transceiver configured to transmit and receive information signals encoded in accordance with a multi-level symbolic scheme.